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Notes on two species of *Boletellus* (*Boletaceae*, *Boletales*) from China

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Abstract — Based on studies of the types and additional materials, *Boletellus emodensis* and *B. obscurecoccineus* are described and illustrated in detail. *Strobilomyces annamiticus* is lectotypified and synonymized with *B. emodensis*; specimens from China regarded as *B. ananiceps* are confirmed to represent *B. emodensis*; *B. puniceus* and *Boletus megasporus,* originally described from southwestern China, are conspecific with *B. obscurecoccineus.*

Key words — morphology, revision, taxonomy, type studies

Introduction

Species of *Boletellus* Murrill are widely distributed and highly diverse in China, and about twenty-five taxa have been reported from the country (Chiu 1948, 1957; Teng 1963; Bi et al. 1982, 1984, 1997; Wen 1985; Zang 1985; Zang & Yuan 1999; Zang et al. 1999; Li & Song 2003). Recently, some field and laboratory observations on the species of genus *Boletellus* from southern and southwestern China were made, and several herbarial specimens including the types of two species were re-examined. The field observations and critical re-examinations indicate that some purported species of the genus are later synonyms. Thus, our new findings update characteristics and distributions for *B. emodensis* and *B. obscurecoccineus*.

Materials & methods

Basidiomata were collected during the rainy season (April–September) in southern and southwestern China. Specimens were described and/or photographed in the field, dried, and then deposited in the Herbarium of Cryptogams, Kunming Institute of Botany, Chinese Academy of Sciences (HKAS). Additional collections from the

Farlow Herbarium, Harvard University (FH), and the Fungal Herbarium of Guangdong Institute of Microbiology (GDGM) were examined. 5% KOH was used as a mounting medium for microscopic studies. The notations "basidiospores (n/m/p)" indicate that the measurements were made on n basidiospores from m basidiomata of p collections. Dimensions of basidiospores including the ornamentation are given using notation of the form (a) b-c (d); the range b-c contains a minimum of 90% of the measured values, and extreme values a and d are given in parentheses. Q refers to the length/breadth ratio of basidiospores; Q_m refers to the average Q of basidiospores ± sample standard deviation. All line drawings of microstructures were made from rehydrated material.

Taxonomy

Boletellus emodensis (Berk.) Singer, Annls mycol. 40: 19, 1942. Figs. 1–11

≡ *Boletus emodensis* Berk., Hook. J. Bot. Kew Gard. Misc. 3: 48, 1851.

= *Strobilomyces annamiticus* Pat., Bull. Soc. Mycol. Fr. 25: 6, 1909.

≡ *Boletellus annamiticus* (Pat.) E.-J. Gilbert, Les Bolets: 107, 1931.

[The description below is based on HKAS 59211, HKAS 59213, GDGM 13229, HKAS 59214, HKAS 59212, HKAS 37832, and HKAS 54741.]

Macrocharacters — Basidiomata medium-sized. Pileus 4.5–9 cm in diameter, convex to applanate; surface dry, purple to dull crimson, usually fading to pale fawn in age, finely tomentose when young, then cracking into large squamules; margin at first extended into a false veil and covering the pores, then splitting radially, appendiculate with false veil remnants; context 0.8–1.1 cm thick in the center of pileus, yellowish, cyanescent strongly and rapidly when injured. Hymenophore poroid, yellow, cyanescent strongly and rapidly when injured, depressed around apex of stipe; pores 0.1–0.2 cm in diameter, simple, angular. Stipe central, 6–8 × 0.8–1 cm, cylindric, solid, firm; surface dry, fibrous, concolorous with the pileus, but apex yellowish; base usually enlarged and villous with white mycelium; context yellow, cyanescent strongly and rapidly when injured. Annulus absent (Figs. 1–5).

Microcharacters — Basidia 34–52 × 11–17 μm, clavate, colorless to yellowish brown in KOH, 4-spored (occasionally 2- or 3-spored) (Fig. 6). Basidiospores [260/13/7] (16–)18–23(–25) × (7–)8–10(–12) μm, Q = (1.70–)1.89–2.75(–2.87), Q_m = 2.28 ± 0.24, yellowish to yellowish brown in KOH, elongate-subfusoid to elongate-ellipsoid, with longitudinal or oblique ridges, 7–9 ridges visible in lateral view; ridges up to 1–1.5 μm in height, round in transverse section, having distinct transverse striations on the ridges (Figs. 7–9). Tube trama made up of thin-walled, colourless to yellowish hyphae 5–13 μm in width. Cheilocystidia 48–66 × 11–16 μm, subfusiform to fusiform, thin-walled, colorless or yellowish to yellowish brown in KOH (Fig. 10). Pleurocystidia 70–90 × 11–18 μm, subfusiform to fusiform, colorless to yellowish brown in KOH (Fig. 6). Pileipellis an intricate trichoderm composed of interwoven,

Figs. 1–2: Basidiomata of *Boletellus emodensis* (HKAS 59212). 1. Immature basidioma (HKAS 59215). 2. Fruiting habit on tree stump in forest dominated by *Fagaceae*, Fujian, China.
Bars = 2 cm.

thin-walled, yellowish to yellowish brown hyphae; terminal cells 19–35 × 7–11 µm, with round to obtuse apex (Fig. 11). Pileal trama made up of thin-walled, colorless to yellowish hyphae 5–15 µm in diameter. Clamps absent in all tissues.

Habit, habitat, distribution — Solitary or gregarious on the ground, tree stumps or rotten wood in forests dominated by *Fagaceae*; originally described from India; then reported from southeast Asia (Corner 1972, Horak 1977), east Asia (Hongo & Izawa 1994, Chen et al. 1997, Mao 2009, An 1998), and Australia (Young 2004).

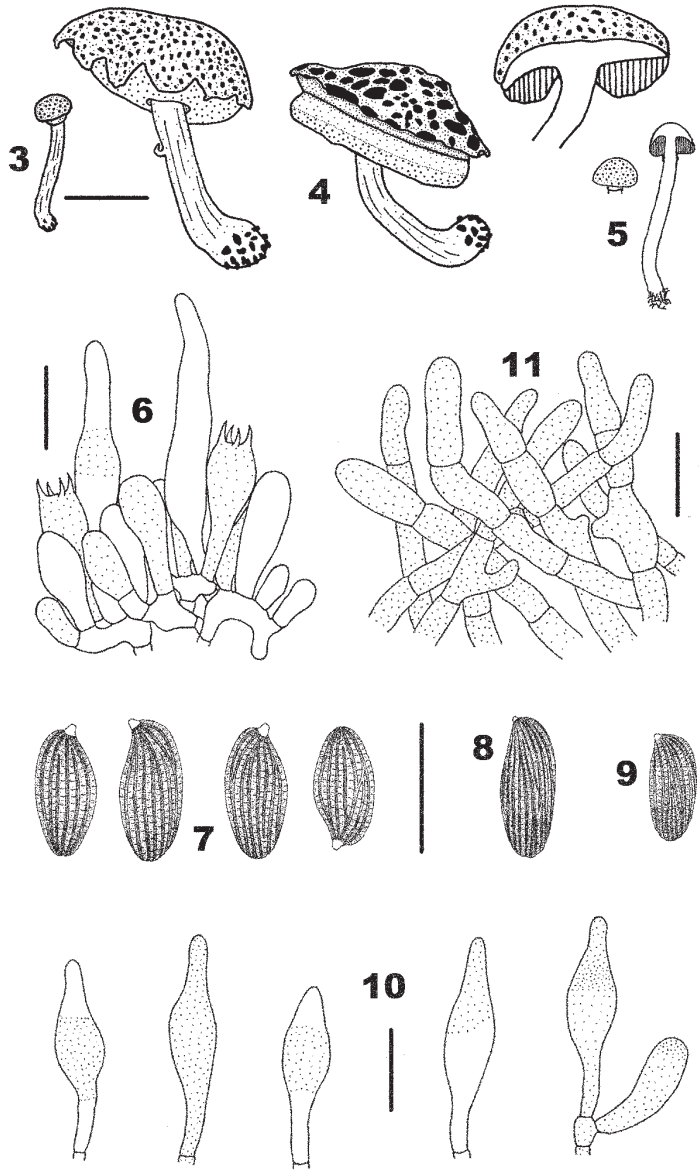
Specimens examined — **Vietnam**. **Tonkin**: Rives du Kam-ly, 1907, det. N.T. Patouillard, Eberhardt LBA 161 (FH 3720 pro parte, ***Strobilomyces annamiticus* lectotype designated here**); Vallée du Da-Pounian, 1907, det. N.T. Patouillard, Eberhardt LBA 209 (FH 3720 pro parte, *Strobilomyces annamiticus*). **China**. **Hainan Province**: Baisha County, Yinggeling Mountain, alt. 747 m, 28 July 2009, N.K. Zeng 384 (HKAS 59211); same location and date, alt. 841 m, N.K. Zeng 379 (HKAS 59215); Qiongzhong County, Limushan Mountain, alt. 869 m, 4 August 2010, N.K. Zeng 829 (HKAS 59213); Ledong County, Jianfengling Mountain, 4 October 1987, T.H. Li s. n. (GDGM 13229, as "*B. ananaeceps*" in Bi et al. 1997); **Guangdong Province**: Zhaoqing County, Dinghushan Mountain, alt. 233 m, 9 August 2010, N.K. Zeng 867 (HKAS 59214); **Fujian Province**: Zhangping County, Xinqiao Town, Chengkou Village, alt. 357 m, 3 September 2009, N.K. Zeng 674 (HKAS 59212); **Yunnan Province**: Jingdong County, Qincaitang, 15 September 1999, Q.B. Wang 282 (HKAS 37832); Jiangcheng County, alt. 1400 m, 29 July 2008, L.P. Tang 510 (HKAS 54741).

Comments — *Boletellus emodensis* is well characterized by its purple to dull crimson pileus, a yellow context in both pileus and stipe that is strongly and rapidly cyanescent in both when injured, longitudinally ridged basidiospores with fine cross-striations on the ridges observable with the light microscope. Although *B. emodensis* is quite common throughout east and southeast Asia, it was not well characterized until the publication by Corner (1972).

Strobilomyces annamiticus was described based on collections from Vietnam (Patouillard 1909) and later transferred to *Boletellus* by Gilbert (1931). One of us (ZLY) studied the syntypes of *S. annamiticus* deposited in Farlow Herbarium, Harvard University (FH 3720), which consist of two collections, both identified as *S. annamiticus* by N.T. Patouillard. One collection (Eberhardt LBA 161) is composed of a single fruitbody (Fig. 5). The dried cap is about 1 cm in diameter, convex, dark chocolate brown, covered with dull chocolate brown tomentose squamules, and the pileal margin is appendiculate. The stipe is 7 × 0.3 cm, with the base apparently attached to wood. The basidiospores (Fig. 8) are [20/1/1] (20–)21–24(–26) × (6.5–)7–8.5 μm, Q = 2.63–3.29(–3.69), Q_m = 2.95 ± 0.30, yellowish to yellowish brown in KOH, elongate-subfusoid to elongate-ellipsoid, with longitudinal or oblique ridges, 7–9 ridges visible in lateral view, with ridges up to 1 μm in height, having indistinct transverse striations on the ridges. The other collection (Eberhardt LBA 209) consists of a dried cap which is 1.5–2 cm in diameter, convex to applanate, dark to blackish. The stipe is 5 × 0.2–0.4 cm, on rotten wood. The basidiospores (Fig. 9) are [20/1/1] (15–)16–18 × (6.5–)7.5–8.5 μm, Q = (1.76–)1.88–2.33(–2.46), Q_m = 2.10 ± 0.16, yellowish brown in KOH, elongate-subfusoid to elongate-ellipsoid, with longitudinal or oblique ridges, 7–9 ridges visible in lateral view, with ridges up to 1 (1.5) μm in height, round in transverse section, having distinct transverse striations on ridges.

In the protologue of *Strobilomyces annamiticus*, Patouillard (1909) cited two localities that correspond exactly with the localities of the collections Eberhardt LBA 161 and Eberhardt LBA 209. Eberhardt LBA 161 is designated here as lectotype. Singer (1945) regarded the two Vietnamese collections as immature basidiomata of *B. emodensis*, and *S. annamiticus* was synonymized with *B. emodensis*. With our re-examination of the syntypes and field observation on other collections, the present authors are convinced that the basidiomata of the two Vietnamese collections are the same as immature basidiomata of *B. emodensis*, because the size of basidiospores of *B. emodensis* may be variable at different stages of basidioma development. For example, the basidiospores of one immature basidioma (HKAS 59215) are [20/1/1] 15–18(–19) × 5–7 μm, with Q = (2.14–)2.29–3.17(–3.20) and Q_m = 2.73 ± 0.28. They are clearly much shorter and narrower when compared to mature collections. This explains why the basidiospores from the two Vietnamese collections are slightly narrower (and Eberhardt LBA 209 slightly shorter) compared with mature Chinese material and the holotype (20–24 × 8–10 μm) (Pegler & Young 1971: 163) of *B. emodensis*, and further confirms that *S. annamiticus* is a synonym of *B. emodensis*, as noted by Singer (1945).

Boletellus ananiceps (Berk.) Singer, originally described from Australia, is allied to *B. emodensis*. However, *B. ananiceps* has been noted to differ from



Figs. 3–11: *Boletellus emodensis* (= *B. annamiticus*) [3 from HKAS 59215; 4 from HKAS 59212; 5, 8 from Eberhardt LBA 161 of FH 3720 (*B. annamiticus*); 6, 7, 10, 11 from HKAS 59211; 9 from Eberhardt LBA 209 of FH 3720 (*B. annamiticus*)]. 3–5. Basidiomata. 6. Basidia and pleurocystidia. 7–9. Basidiospores. 10. Cheilocystidia. 11. Pileipellis. Bars: 3–5 = 2 cm, 6–11 = 20 μm.

B. emodensis by its longitudinally ridged basidiospores that lack cross-striations on the ridges (Singer 1955, Bougher & Syme 1998, Halling & Fechner 2011). In China, *B. ananiceps* was previously reported from Hainan (Bi et al. 1997) with three cited collections (GDGM 13229, GDGM 16785, GDGM 15741). Unfortunately, the voucher specimens GDGM 16785 and 15741 were lost (Ms. Z.D. Xiao, personal communication). Re-examinations of GDGM 13229 showed that that collection is identical to *B. emodensis* in its purple to dull crimson pileus and obvious cross-striations on the basidiospore ridges. Therefore, whether *B. ananiceps* occurs in China remains to be confirmed.

Boletellus ananas (M.A. Curtis) Murrill, a species originally described from USA, is also allied with *B. emodensis*. However, the pileus of the former is pink or red when fresh and becomes pale fuscous tan when it fades; the stipe is never red, as in *B. emodensis*; the squamae in *B. ananas* are coarse, while in *B. emodensis* usually fine. Furthermore, the ridges on the basidiospores are broader than those of *B. emodensis* (Halling 2010). In China, *B. ananas* was previously reported from the south of China (Chiu 1948, 1957; Teng 1963; Zang 1985; Bi et al. 1994). Judging from their descriptions, these reports may represent *B. emodensis*. Thus, whether *B. ananas* occurs in China also needs confirmation.

Boletellus obscurecoccineus (Höhn.) Singer, Farlowia 2:127, 1945. Figs. 12–22

≡ *Boletus obscurecoccineus* Höhn., Sber. K. Akad. Wiss. Wien, Math.-naturw. Kl., Abt. 1, 123: 88, 1914.

= *Boletus puniceus* W.F. Chiu, Mycologia 40(2): 217, 1948.

≡ *Xerocomus puniceus* (W.F. Chiu) F.L. Tai, Syll. Fung. Sin.: 815, 1979.

≡ *Boletellus puniceus* (W.F. Chiu) X.H. Wang & P.G. Liu, Mycotaxon 84: 128, 2002.

= *Boletus megasporus* M. Zang, Acta Microbiol. Sin. 20(1): 30, 1980, as "*magasporus*".

[The description below is based on FH 2993, HKAS 59208, HKAS 59209, and HKAS 59210.]

Macrocharacters — Basidiomata small to medium-sized. Pileus 1.5–7 cm in diameter, convex to applanate; surface dry, pink to pale crimson when fresh, becoming dark purplish red to dark purple when dried, finely tomentose when young, then minutely cracked; context yellowish, unchanging in color when injured. Hymenophore poroid, yellow, unchanging in color when injured, depressed around apex of stipe; pores 0.1– 0.2 cm in diameter, simple, angular. Stipe central, 3–5 × 0.2–0.8 cm, cylindric, slightly attenuate upwards, solid, firm, apex yellowish, middle finely tomentose when young, then fracturing into pale crimson squamules, with base usually enlarged and villous with white mycelium; context whitish, unchanging in color when injured. Annulus absent (Figs. 12–16).

Microcharacters — Basidia 42–55 × 8–12 μm, clavate, colorless to yellowish in KOH, 4-spored (sometimes 2- or 3-spored) (Fig. 17).

Figs. 12–13: Basidiomata of *Boletellus obscurecoccineus* (HKAS 59208). 12. Fruiting habit on soil in forest dominated by *Lithocarpus*, Hainan, China. 13. Ventral. Bars = 2 cm.

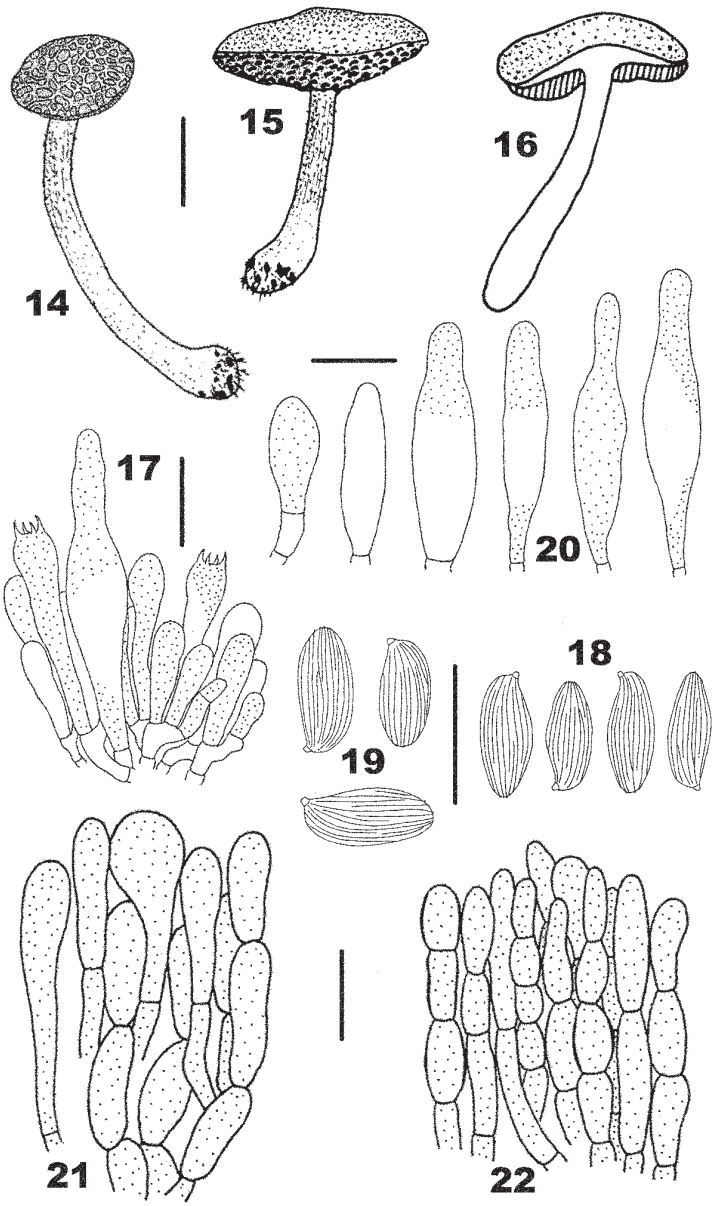
Basidiospores [140/7/4] (14–)14.5–18(–20.5) × (5–)6–8(–9.5) μm, Q = (1.81–)2.00–2.77(–3.30), Q_m = 2.32 ± 0.26, brownish to pale ochraceous in KOH, elongate-subfusoid to elongate-ellipsoid, with 7–10 faintly longitudinal ridges in lateral view, not transversely striate on ridges (Figs. 18–19). Tube trama made up of thin-walled hyphae 4–9 μm in width, colorless to yellowish in KOH. Cheilocystidia 32–87 × 11–17 μm, subfusiform to fusiform, thin-walled, colorless to yellowish in KOH (Fig. 20). Pleurocystidia similar to cheilocystidia (Fig. 17). Pileipellis an epithelioid trichoderm made up of vertically arranged, ellipsoid, occasionally sphaeropedunculate, thin-walled (sometimes up to 1 μm in thickness), yellowish to yellowish brown hyphae; terminal cells 22–54(–90) × 9–15(–60) μm, with round to obtuse apex (Figs. 21–22). Pileal trama made up of thin-walled, colorless to yellowish hyphae 6–12 μm in diameter. Clamps absent in all tissues.

Habit, habitat, distribution — Solitary or scattered on the ground in forests of *Lithocarpus* (*Fagaceae*), occasionally on rotten wood; originally described from Indonesia (Höhnel 1914: 88), and later reported from east Asia (Hongo 1970, Wen 1985, Chen et al. 1997, An 1998, Wang & Liu 2002, Yuan & Sun 2007), southeast Asia (Corner 1972, Horak 1977) and Australia (May & Wood 1997, Bougher & Syme 1998).

Specimens examined — **Indonesia**. **Java**: Tjibodas, 1908, leg. F.X.R. v. Höhnel, *Boletus* 1187 (FH 2993, holotype). **China**. **Hainan Province**: Baisha County, Yinggeling Mountain, alt. 943 m, 26 July 2009, N.K. Zeng 328 (HKAS 59208); same location and date, alt. 968 m, N.K. Zeng 335 (HKAS 59209); same location, alt. 824 m, 28 July 2009, N.K. Zeng 367 (HKAS 59210).

Comments — *Boletellus obscurecoccineus* is well characterized by its pink to pale crimson pileus, faintly longitudinally ridged basidiospores combined with the broad pores, and non-cyanescent context.

One of us (ZYL) studied the holotype of *B. obscurecoccineus*, which consists of two and a half basidiomata. The dried cap is about 3–5 cm in diameter, the



Figs. 14–22: *Boletellus obscurecoccineus* (14, 17, 20, 22 from HKAS 59210; 15, 18 from HKAS 59208; 16, 19, 21 from FH 2993, holotype).14–16. Basidiomata. 17. Basidia and pleurocystidium. 18–19. Basidiospores. 20. Cheilocystidia. 21–22. Pileipellis. Bars: 14–16 = 2 cm, 17–22 = 20 μm.

pileal surface is finely tomentose and dark purplish red to dark purple when dried, the hymenophore is umber-brown, with pores about 1 mm in diameter, the stipe (4–5 × 0.4–0.6 cm) attenuates slightly upwards, and the surface is finely tomentose, whitish to ochraceous, much paler than cap (Fig. 16). Basidia and cystidia would not rehydrate sufficiently for study. Basidiospores (Fig. 19) are [21/1/1] (15–)16–20.5 × 7.5–8.5(–9.5) μm, Q = 2.00–2.38(–2.47), Q_m = 2.20 ± 0.13, brownish to pale ochraceous in KOH, elongate-subfusoid to elongate-ellipsoid, with 7–10 faint longitudinally ridges in lateral view, without transverse striations on ridges. The pileipellis (Fig. 21) is an epithelioid trichoderm made up of vertically arranged, moniliform hyphae with ellipsoid, occasionally sphaeropedunculate, thin-walled elements, often with yellowish-brownish vacuolar pigment; terminal cells are 25–50(–90) × 10–15(–60) μm, with round to obtuse apex.

Boletus puniceus was originally described from Yunnan, China (Chiu 1948, 1957). Without examining the type of *B. puniceu*s, Corner (1972) suspected *B. puniceu*s was conspecific with *B. obscurecoccineus*. Wang & Liu (2002) re-examined the type of *B. puniceu*s (HMAS3852) and found the basidiospores to be [74/1/1] 15–18(–19.3) × (6.3–)6.7–8(–9) μm, Q = (1.90–)2.05–2.54(–2.64), Q_m = 2.30 ± 0.16, with faint longitudinal ridges, and the species was transferred to *Boletellus*, with *Boletus megasporus* included as a synonym. The present type studies showed no essential differences among *B. obscurecoccineus*, *B. megasporus* and *B. puniceus,* suggesting that they are conspecific.

Mao (2000: Fig. 830) published a photo labelled as *Aureoboletus* [as "*Austreoboletus*"] *thibetanus* (Pat.) Hongo & Nagas. Judging from the features of the basidiomata in the photo, it may represent *B. obscurecoccineus*, as previously noted by Yang et al. (2003).

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Literature cited

An YH. 1998. Notes on Korean *Strobilomycetaceae* (II) — On *Boletellus*. Korean J. Mycol. 26(2): 211–229.

Bi ZS, Lu DJ, Zheng GY. 1982. Basidiomycetes from Dinghu Mountain of China II. Some new species of *Boletaceae* (1). Acta Bot. Yunnan. 4: 55–64.

Bi ZS, Li TH, Zheng GY, Li C. 1984. Basidiomycetes from Dinghu Mountain of China III. Some species of *Boletaceae* (2). Acta Mycol. Sin. 3(4): 199–206.

Bi ZS, Zheng GY, Li TH. 1994. Macrofungus Flora of Guangdong Province. Guangzhou: Guangdong Science and Technology Press.

Bi ZS, Li TH, Zhang WM, Song B. 1997. A preliminary agaric flora of Hainan Province. Guangzhou: Guangdong Higher Education Press.

Bougher NL, Syme K. 1998. Fungi of Southern Australia. Western Australia: University of Western Australia Press.

Chen CM, Huang HW, Yeh KW. 1997. The boletes of Taiwan (VI). Taiwania 42: 154–160.

Chiu WF. 1948. The boletes of Yunnan. Mycologia 40: 199–231. doi:10.2307/3755085

Chiu WF. 1957. Atlas of Yunnan boletes. Beijing: Science Press.

Corner EJF. 1972. *Boletus* in Malaysia. Singapore: Government Printer.

Gilbert EJ. 1931. Les Bolets. Paris.

Halling RE. 2010. Identification aid: *Boletellus* sect. *Boletellus*. Surveys & revisions in *Boletineae*. http://www.nybg.org/bsci/res/hall/boletes/ananas_v_emodensis.html

Halling RE, Fechner NA. 2011. Toward a concept for *Boletellus ananiceps*. Fungimap Newsletter 42: 3–4.

Höhnel FXR von. 1914. Fragmente zur Mykologie (XVI. Mitteilung, Nr. 813 bis 875). Sber. K. Akad. Wiss. Wien, Math.-naturw. Kl., Abt. 1, 123: 49–155.

Hongo T. 1970. Notulae mycologicae (9). Mem. Fac. Educ. Shiga Univ., Nat. Sci. 20: 49–54.

Hongo T, Izawa M. 1994. Yama-Kei field books No. 10. Tokyo: Yama-Kei.

Horak E. 1977. *Boletellus* and *Porphyrellus* in Papua New Guinea. Kew Bull. 31(3): 645–652. doi:10.2307/4119416

Li TH, Song B. 2003. Bolete species known from China. Guizhou Sci. 21(1–2): 78–86.

Mao XL. 2000. The macrofungi in China. Zhengzhou: Henan Science and Technology Press.

Mao XL. 2009. Macromycetes of China. Beijing: Science Press.

May TW, Wood AE. 1997. Catalogue and bibliography of Australian macrofungi 1. *Basidiomycota* p.p. Fungi of Australia volume 2A. Australian Biological Resources Study: Canberra.

Patouillard NT. 1909. Quelques champignons de l'Annam. Bull. Soc. Mycol. France 25: 1–12.

Pegler DN, Young TWK. 1971. Basidiospore morphology in the Agaricales. Beih. Nova Hedwigia 35: 1–210, pls. 1–53.

Singer R. 1945. The *Boletineae* of Florida with notes on extralimital species. I. The Strobilomycetaceae. Farlowia 2: 97–141.

Singer R. 1955. Type studies on *Basidiomycetes.* VIII. Sydowia 9: 367–431.

Teng SC. 1963. Fungi of China. Beijing: Science Press.

Wang XH, Liu PG. 2002. Notes on several boleti from Yunnan, China. Mycotaxon 84: 125–134.

Wen HA. 1985. New species and new records of genus *Boletellus* from China. Acta Mycol. Sin. 4: 222–226.

Yang ZL, Wang XH, Binder M. 2003. A study of the type and additional materials of *Boletus thibetanus*, Mycotaxon 86: 283–290.

Young T. 2004. A field guide to the fungi of Australia. Sydney: University of New South Wales Press.

Yuan MS, Sun PQ. 2007. Atlas of Chinese mushrooms. Chengdu: Sichuan Science and Technology Press.

Zang M. 1980. Some new species of *Basidiomycetes* from the Xizang Autonomous Region of China. Acta Micro. Sin. 20: 29–34.

Zang M. 1985. Notes on the *Boletales* from eastern Himalayas and adjacent of China. Acta Bot. Yunnan. 7: 383–401.

Zang M. 2006. Flora Fungorum Sinicorum. Vol. 22. *Boletaceae* (I). Beijing: Science Press.

Zang M, Yuan MS. 1999. Contribution to the knowledge of new basidiomycoteous taxa from China. Acta Bot. Yunnan. 21: 37–42.

Zang M, Chen CM, Sittigul C. 1999. Some new and interesting taxa of *Boletales* from tropical Asia. Fungal Sci. 18: 19–25.